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PROSPECTIVE SITES FOR LARGE STEAM PLANTS

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PROSPECTIVE SITES FOR LARGE STEAM PLANTS

Norman F. Williams,[1] M. ASCE

SYNOPSIS

The general area for a proposed steam electric plant on a utility system is generally selected from a consideration of present loads, deficit load areas, future load growths, fuel costs, transmission line losses, transmission requirements, etc. Having selected the general area, the engineering and other factors, which must be evaluated in choosing the final site in this general area, are pointed out and discussed.

INTRODUCTION

Over the past 13 years, there have been added to The Southern Company system fourteen large steam plants in the States of Alabama, Florida, Georgia, and Mississippi. In selecting these specific sites, certain general principles have been found applicable. They are presented as a general guide of the things to look for and the conditions to beware of. Without attempting to put them in any particular order, the following should be given consideration:

Foundations

In order of decreasing desirability, the different general types of foundations are:

A - Rock foundation.
B - Foundation composed primarily of sand.
C - Foundation composed primarily of silt.
D - Foundation composed primarily of clay or with thick clay beds.

Of the four types listed above, we have found that generally the most economical treatment of the clay type foundation is to shift the plant off the clay onto an area underlain by sand, or, if this is not possible to find another site. This we have done on all Southern Company plants. It is, of course, a question of economics, but generally it is cheaper to find another site than to design for the large differential settlements involved on a clay, especially soft or highly saturated clays. If a site with a clay foundation is the only one available, it is easy enough to design for this condition, but this is very costly. Silts are occasionally bad actors, but generally have enough sand in them to be all right for foundations. Sands and rocks present many variations, but can generally be used as is or in the case of cavernous rocks made all right by grouting. The least desirable sands are the extremely fine loose sands, especially those which become quick easily, and the most troublesome rocks are limestone, which are often cavernous. It is, of course, seldom possible to know what lies under a proposed site, but often times some indication or information is

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available from nearby highway cuts, existing wells, geologic maps, etc. Actual drilling of any site is always a "must", but any advance information is welcomed as often it will indicate the desirability of a particular type or area of exploration. On soils, it is necessary to do extensive testing, especially shear and consolidation tests on undisturbed samples. This is particularly true where there exist any underlying clay layers. We favor a site where the consolidation computations show that total settlement of the plant will not be over one inch. We have found by experience that we can handle this much difference between a unit which has already been built and already settled and one which we are building without preloading of the new substructure or complications in tying the structural steel of the two units together. We employ the services of a consulting engineer on all foundations and in addition the services of a soil-mechanics consultant on soil foundations. We believe an experienced soil mechanics consultant is better qualified than we are to make and interpret the settlement computations.

Cooling Water

Modern steam plants require approximately three-quarters of a gallon per minute per kilowatt of capacity for cooling water. The trick is to get unpolluted cool water. The only safe way to get cool water is to have enough natural flow in a stream to equal or exceed the three-quarter gallon per minute per kilowatt. Lacking this the next best bet is depth with large volume and a reasonably long circulation path. Depths greater than ten feet generally lower temperatures from one-quarter to one-half degree per foot of depth, but, of course, there is a limit to this when large capacities are involved. Circulation paths with little or no depth are highly questionable especially in the southern part of our system, where high humidities and long daily hot sun periods prevail. With no inflow, the heat that must be removed by natural evaporative cooling, is in the order of 4600 to 5500 Btu per kilowatt-hour depending on unit size, steam temperature, pressure, etc. In a recent extensive study on a site close to the Gulf Coast, it was found that without inflow a cooling pond area between discharge from and intake to the condensers of 275 square feet per kw of capacity was required. This, of course, requires a large body of water for cooling in the size plants under discussion today. Pollution is also of major importance because it may cause rapid clogging of the condenser tubes. This condition is especially bad if it occurs on a body of water that has only limited inflow. Large areas in The Southern Company territory have been discarded for prospective steam plant sites because of this condition. The only sure thing is to locate on a stream whose water is not polluted and whose minimum flow is greater than the maximum requirements of the plant. Lacking either (1) enough stream flow; or (2) enough depth in a bay; or (3) enough area for natural evaporative cooling the only other answer is a cooling tower. Such a plant may be indicated where fuel costs are low and cooling water scarce. We have a plant of this type close to a gas field.

Area Required

The area required for a plant can be extremely small as in the case of some of the plants in the eastern metropolitan areas. However, we have tried to obtain sites that have at least fifty acres in the case of natural gas fired plants and more for coal fired plants. For a square piece of ground, this is approximately 1500 feet on a side. In the case of a coal fired plant, we have three problems that affect area. First, we consider pollution from our stacks. Without dust collecting apparatus and using pulverized coal boilers, the quantity of fly ash going up the stack will vary from one to four grains per cubic foot of

flue gas. This requires an area well removed from towns or cities. With dust collecting apparatus, whose efficiency is in the 85% to 90% range, we get closer to a town, but try to stay five miles away. The second problem in coal fired plants that affects area is coal storage. We store one ton of coal per kw of capacity for a plant entirely on coal and one-half ton of coal per kw of capacity for a plant partly on coal and partly on some other fuel, such as natural gas. Coal in the pile occupies 30 cubic feet per ton, so if the pile averages 30 feet high, there will be required 1.0 square foot per kw for coal storage area. The third problem in coal fired plants that affects area is ash disposal, or rather permanent storage thereof. Based on 6000 hours per year use of the plant, 12 per cent ash content of coal, 90 per cent dust collector efficiency, 0.85 lbs. per kilowatt hour fuel rate, "bottom" ash being 20 per cent of the total ash in the fuel, and an average weight of ash of 65 lbs. per cu. ft., there will be required .0002 acre feet of storage per year per kw of capacity. This storage must be in a location where it will not wash into the river. We provide 30 years ash storage for a large plant. For 1,000,000 kw, this would require 6000 acre feet and if we stored it ten feet deep we would need 600 acres. A 20 foot depth would be proportional and would require 300 acres.

Roads

A paved road within four miles of a prospective site is highly desirable.

Railroads

Steam plants have been built without railroads into them, but we have not followed this practice. Since coal, over the long pull, will probably be the basic fuel for our area, it is difficult to justify a location without a railroad. For construction purposes, a railroad is a big help, but not a necessity. With minimum cost of railroad track in place over level ground averaging in the neighborhood of $50,000 per mile, the maximum distance from the site to the nearest main line should not be over four miles.

Waterways

It is desirable to have actual or potential competition in the form of barge transportation on an inland waterway. The waterway need not presently have a navigable depth as long as it is capable of development at a reasonable cost. This gives preference to locations on the larger streams or tidal waters. A nine-foot channel is desirable.

Gas Lines

Wherever possible a site should be located close to a trunk gas line even if the primary fuel will not be gas. Most gas lines have a certain amount of dump gas which may be contracted for below the price of the plant's primary fuel. If the plant's primary fuel is gas, it is also important to locate as close to the point, as other conditions warrant, where the gas company has the minimum amount of strengthening to do. This necessitates either discussion with the gas company or a review of their most recent pipe line maps.

Transmission Lines

Two factors are involved - getting construction power in for construction purposes and then getting the plant's energy output out within certain given conditions. Only the first point will be discussed here. It is advantageous to be reasonably close to a source of construction power (not over 500-1000 kw is required on single unit construction depending on the size) so that the main transmission lines need not be built before construction starts. However, this

is not too important a consideration.

Labor Supply

Consideration should be given to the availability of a labor supply. Generally, it is much easier to staff a job where the location is not over fifteen miles from a fair sized community than where the distance is greater. While the policy of different companies varies in respect to houses for operating personnel, the need and pressure for such houses increases as the distance from a livable community increases. Since house costs are high, this can be a sizeable cost item.

Flood Flows

It is desirable, from an economic basis, to have the natural ground above flood levels in order to save the cost of dyking or filling. Along the Gulf and Atlantic Coasts, the hurricane tide level is $\pm$ twelve feet. In general the turbine floor level must be above this lacking other means of protection. Along natural streams, a rating curve must be obtained or developed and the turbine room floor placed above maximum high water. What maximum high water to protect against is an argumentative question. We have been protecting in most cases up to an elevation that would correspond to 35 per cent to 50 per cent of the Myer's formula where $\phi = 10{,}000\sqrt{M}$ and ϕ equals flow in second feet and M = drainage area in square miles. If unit hydrographs are available, we drop a design storm on the drainage area and by the unit hydrograph method compute the flows at the site. On most, but not all streams, if the banks are from 35 to 45 feet above normal water, it will put the turbine floor close to ground surface, give flood protection and make the tunnel elevations about right for minimum low water for condenser bells. It is also desirable to have the river bank of the height discussed come close to the river, rather than be adjacent to intervening low lying bottom lands that lie between the river and the higher banks. This is in order to keep the intake and discharge tunnels to minimum lengths. Such tunnels cost in the range of \$150 to \$250 per lineal foot. Of course, there are exceptions to this and nothing takes the place of an actual layout whose elevations are arrived at after considered judgment of design storms and flood routing procedures.

PROCEEDINGS-SEPARATES

The technical papers published in the past year are presented below. Technical-division sponsorship is indicated by an abbreviation at the end of each Separate Number, the symbols referring to: Air Transport (AT), City Planning (CP), Construction (CO), Engineering Mechanics (EM), Highway (HW), Hydraulics (HY), Irrigation and Drainage (IR), Power (PO), Sanitary Engineering (SA), Soil Mechanics and Foundations (SM), Structural (ST), Surveying and Mapping (SU), and Waterways (WW) divisions. For titles and order coupons, refer to the appropriate issue of "Civil Engineering" or write for a cumulative price list.

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JULY: 457(AT), 458(AT), 459(AT)[e], 460(IR), 461(IR), 462(IR), 463(IR)[e], 464(PO), 465(PO)[e].

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a. Beginning with "Proceedings-Separate No. 200," published in July, 1953, the papers were printed by the photo-offset method.
b. Presented at the Miami Beach (Fla.) Convention of the Society in June, 1953.
c. Presented at the New York (N.Y.) Convention of the Society in October, 1953.
d. Beginning with "Proceedings-Separate No. 290," published in October, 1953, an automatic distribution of papers was inaugurated, as outlined in "Civil Engineering," June, 1953, page 66.
e. Discussion of several papers, grouped by divisions.
f. Presented at the Atlanta (Ga.) Convention of the Society in February, 1954.
g. Presented at the Atlantic City (N.J.) Convention in June, 1954.

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